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Accumulator for Adaptive Sigma-Delta Modulation

Cross Reference to Related Applications

The present application is a continuation-in-part of U.S. Patent Application 10/109,537, filed on March 28, 2002 (which is now a U.S. Patent 6,661,363). This application is also a continuation-in-part of U.S. Patent Application No. 10/357,613, filed on February 4, 2003 (is now a U.S. Patent 6,727,833), which is a continuation of U.S. Patent Application No. 09/496,756, filed February 3, 2000, which issued as U.S. Patent 6,535,153 and claims priority from U.S. provisional application number 60/118,607, filed February 4,1999. Each of the above-mentioned applications is hereby incorporated herein by reference.

Technical Field

The invention generally relates to signal processing, and more particularly, to analog to digital conversion using sigma-delta modulation.

Background Art

Sigma-delta (Σ-Δ) modulation is a widely used and thoroughly investigated technique for converting an analog signal into a high-frequency digital sequence. See, for example, "Oversampling Delta-Sigma Data Converters," eds. J. C. Candy and G. C. Temes, IEEE Press, 1992, (hereinafter Candy) and "Delta-Sigma Data Converters," eds. S. R. Northworthy, R. Schreier, G. C. Temes, IEEE Press, 1997, both of which are hereby incorporated herein by reference.

In Σ-Δ modulation, a low-resolution quantizer is incorporated within a feedback loop configuration in which the sampling frequency is much higher than the Nyquist frequency of the input signal (*i.e.*, much higher than twice the maximum input frequency). In addition, the noise energy introduced in the quantizer is shaped towards higher frequencies according to a so called "noise-transfer-function" NTF(z), and the signal passes the modulator more or less unchanged according to a so called "signal-transfer-function" STF(z).

Fig. 1(a) depicts a simple first order Σ-Δ modulator for a discrete time system having a subtraction stage 101, an accumulator 102 (including an integrator adder 103 and a delay line 104), a one-bit quantizer 105, and a 1-bit digital-to-analog converter